Modelling 3-D Objects

The present invention relates to a method and system for computer aided design or modelling of a three-dimensional object and to a computer program for use in the method and system.

There is a growing need in the general field of design for a simple and rapid technique for computer aided modelling and modifying models of objects, for example to allow the creation of objects whose design is suitable for a particular environment. A non-exhaustive list of such objects includes car interiors, boat interiors, aircraft cabin layouts, retail outlet layouts including racking, shelving etc, roofs, lighting and other electrical installations, warehouses, furniture, buildings such as houses and factories, and gardens or parks.

A number of computer aided design and visualisation programs are currently available but these lack a simple user interface and also lack the ability to be customised for a particular application. For example in the general field of interior design, although it may be possible to provide a reasonable simulation of an interior space of a building, it is not readily possible to provide flexibly variable images of furniture and accessories to enable the features of the design to be appreciated. Moreover it is not readily possible to address issues of the general design and utility of the rooms of a building by creating a simulation of the rooms and then by testing the design by trying different furniture items and accessories so as adaptively to modify the design of the building to achieve optimal effect.

Although such desiderata could be met by writing custom programs for particular functions, there is a need for a tool that enables rapid visualisation of objects within an environment, with the facility to vary either or both of the objects and the environment at will. There is a further need in the art for such a tool to enable a manufacturing report readily to be derived from a model of such an environment containing objects, which model is capable of display as a visual report.

According to a first aspect of the present invention there is provided a computer aided method of modelling a three-dimensional object, comprising the steps of

providing data defining a frame representing a three-dimensional space for the object, wherein the frame has associated dimension data, displaying an image representing the frame, selecting a component from a library of components, selecting a location in the frame to apply the component, and applying the selected component to the frame at said location, wherein the applying step comprises accessing the dimension data of the frame, scaling the dimensions of the component to the frame, and displaying the scaled component in the frame, wherein the scaled component represents at least part of the object being modelled.

In a preferred embodiment the step of scaling the component to the frame may include repeating the component to provide a tessalated surface of e.g. tites or brickwork.

Where the object is a roof, the frame may represent the roof envelope and the library of components may include tiles, ridge tiles and under tile-felt, battens etc. The roof can, by use of embodiments of the invention, be modelled and reports thereby be generated showing either the visual appearance of the roof, or the component count to enable quantity listings, or both.

Where the object is an item of furniture, the frame may represent an envelope of the item of furniture and the library of components may include top, bottom, side door and drawer components of the item of furniture. Other fields of application are mentioned above.

In a preferred embodiment the frame data comprises constraint data and the component data comprises compliance data, wherein the applying step comprises testing the compliance data to determine whether it conforms to the constraint data and thereby controlling the step of displaying the adapted component in the frame.

In an embodiment constraint data comprises a specification data specifying allowed components for the said frame, and the controlling step comprises enabling display if the compliance data of the selected component indicates that the selected component is allowed for said frame.

For example, where the frame represents a frame for an item of furniture, the constraint data may specify only furniture-type components so that if a user attempts to select a non-furniture component such as a roof tile, the selected component cannot be displayed in the furniture item frame.

In an embodiment constraint data comprises specification data specifying at least one allowed orientation of at least one component for the said frame and the applying the step comprises disposing the component in a chosen orientation, and the controlling step comprises enabling display if the compliance data of the selected component indicates that the selected component is allowed to be in the chosen orientation for the said frame.

If for example the selected component were a side panel of a furniture item, and the constraint data for the portion of the frame under consideration specified only top panels for that location, in an embodiment the controlling step prevents display of the side panel in an incorrect orientation.

In an embodiment the constraint data comprises specification data specifying at least one allowed disposition of at least one component for the said frame, wherein the applying step comprises disposing the component in a chosen disposition and the controlling step comprises enabling display if the compliance data of the selected component indicates that the selected component is allowed to be in the chosen disposition for the said frame.

For example, if the location on the frame required a top panel and the selected component were instead a bottom panel then the discrepancy between the "top" requirement of the constraint data by differing from the "bottom" attribute of the compliance data may, in embodiments, prevent display of the component in the wrong disposition.

In many embodiments the method comprises selecting at least one further component from the library, displaying the selected further component and applying the selected further component to the frame, wherein the applying step comprises accessing the dimension data of the frame, adapting the further components to the frame and displaying the adapted further component in the frame.

In this way, a model of a complete object can be provided.

In embodiments the method comprises modifying at least one of the size, orientation or disposition of the frame, whereby the or each displayed component varies correspondingly.

In a simple case modification of the size of the frame can merely cause the displayed components to vary proportionately. Hence, for example, where a cabinet having two doors is varied in size, the doors vary as the image of the cabinet is varied. However, often there is a need to allow for more complex rules to be followed. For example where a chest of drawers is increased in height, the number of drawers may need to vary so as to maintain the correct proportion. Again, one part of a component may vary differently to another, and some parts (such as handles and spacings of keyholes from the edge of an object) may be of constant dimension.

According to a second aspect of the present invention there is provided a method of deriving manufacturing data for a three-dimensional object comprising the method of the first aspect and further comprising outputting data derived from the adapted frame and adapted components such as manufacturing data.

It will be understood that the processing steps that are necessary to provide a model of an object composed of its various components, can in embodiments be rapid processing steps especially where the prime need is for a report showing a visual image. A suitable technology is Direct-X. Embodiments are also capable of textual reports including quantity data and cost information.

According to a third aspect of the present invention there is provided a system constructed and arranged for computer aided design or modelling a three-dimensional object, the system comprising a component store for storing a data defining of a library of components and a user input device operable to input data defining a frame representing a three-dimensional space for the object, to select a component from the library of components, and to apply the selected component to the frame. The system comprises a display screen for displaying the frame and for displaying the selected component, and a processor for running a stored program operable to derive dimension data for the frame, to access the

dimension data of the frame, to adapt data representing the component to the dimension data of the frame and to provide the adapted data to the display screen whereby the display screen displays the adapted component in the frame as at least one part of the object.

In an embodiment the system further comprises a frame store for data defining plural frame types, each said type having associated data representing constraints, wherein the user input device is operable to select a frame type from said plural frame types, and each component of said library of components has associated data representing compliance information, wherein the stored program is operable to test the compliance data of a selected component to determine whether it conforms to the constraint data of the selected frame type and therefore controlling adaptation of said data representing the components to affect the display of the adapted component in the frame.

In an embodiment the constraint data comprises specification data specifying at least one of the group comprising allowed components for the said frame, and on allowed orientation of at least one component for the said frame type and an allowed disposition of at least one component for the said frame type.

In an embodiment the stored program is operable to adapt the component data if the compliance data of the selected component indicates that the selected component is allowed for the said frame type.

In an embodiment the user device is arranged to allow a user to choose an orientation for the selected component, and the stored program is operable to adapt the component data to represent the chosen orientation to thereby enable display if the compliance data of the selected component indicates that the selected component is allowed to be in the chosen orientation for the said frame type.

In an embodiment the user input device is arranged to allow a user to choose a disposition for the selected component, and the stored program is operable to adapt the component data of the selected component to represent the chosen disposition of the component to thereby enable display if the compliance data of

the selected component indicates that the selected component is allowed to be in the chosen disposition for the said frame type.

In an embodiment the user input device is operable to allow a user to modify the data defining at least one of the sides, orientation and disposition of the frame, and the stored program is operable to correspondingly adapt the component data for the or each component displayed in the frame whereby the object displayed varies.

Further embodiments of the invention provide a means by which a user can selectively obtain technical information relating to the structure of an object by navigating a graphic image of the object. Preferred embodiments allow the user to select specific areas of the object, for example joints or beams, and to be provided with information such as construction instructions or a list of components relating to that specific area.

Further embodiments enable the user to tunnel down into particular areas of the object to increase the detail of the information provided.

An embodiment of the present invention will now be described with reference to the accompanying drawings in which:
Figure 1 shows a block diagram of a computer system implementing a method embodying the invention;
Figure 2 shows an exemplary screen of a device implementing a method embodying the invention;
Figure 3 shows an image of a chest of drawers in two configurations; and
Figure 4 shows an illustrative data structure.
Figure 5 is a flow diagram showing the steps performed by a preferred embodiment of the invention.
Figure 6 shows an image presented by a preferred embodiment of the invention.
Figure 7 shows an image including dimension data presented by a preferred embodiment.
Figure 8 shows a magnified image presented by a preferred embodiment.
Figure 9 shows a magnified image which identifies points of the image on which construction data can be retrieved.
Figure 10 shows an example of a display in which data relating to materials

required by a selected point of the image has been retrieved.

Figure 11 shows a further image indicating all points about which further data may be retrieved.

Figure 12 shows an object in a frame.

Figure 13 shows the data available for a selected object.

Figure 14 shows an object positioned within a magnifier window.

Figure 15 shows the links to data associated with a selected object.

Figure 16 shows the data available for a selected layer of the object.

Figure 17 shows the data available for a selected and edited object.

In the various figures like reference numerals refer to like parts.

As will be clear to those skilled in the art embodiments of the present invention require the use of frames and components. In the present context a frame is a three-dimensional construct which has the following properties.

1. Frames may be constructed or varied by a designer or may be derived from a series of fundamental frames.
2. Frames may be added together.
3. Frames may be disposed within other frames. If this happens and where a parent frame has a co-ordinate system the child frame may or may not be linked to the co-ordinate system.
4. Frames may be hierarchically arranged. For example a building can be regarded as a hierarchical related series of frames including a site frame, an external frame for the building structure, room frames (which must fit within the structure) and furniture frames. Each of these frame types has associated data which allows different components to be placed in the frames. Furthermore, each frame type will respond differently to adjoining frames.
5. Frames can contain not only three-dimensional geometry which determines the display characteristics of components but may also contain attribute data relevant to the particular type of frame. An example is that a room frame is likely to have information indicative of which portion is to be a floor, which to be a ceiling, which to be an external wall and which to be an internal wall.

The skilled person will also be aware that the invention requires the use of components. Components are parametric, possibly composite, data constructs whose geometric parameters are defined by the frame into which the construct is "placed". In one series of embodiments the system of the invention uses a graphical user interface, and the components are applied to their frames by dragging and dropping.

It is envisaged that specific embodiments of the invention are customised for particular applications. Thus the method and system of the invention in its general sense relates only to a method and system for modelling objects. However, specific embodiments are envisaged as including custom content so that for example one embodiment could relate entirely to the design, modelling and visualisation of interior design of buildings, another embodiment to garden design and another embodiment to housing development planning. In such embodiments, the custom content of the particular embodiment is held separate from the underlying processes. The custom information may be formed by the use of an XML file system.

Referring now to Figure 1. A system (1) for modelling a three-dimensional object comprises a component memory (10) for storing a library (11) of components, and a user input device (20) such as a keyboard, mouse or the like which is operable to define a frame (200-see Figure 2). The frame represents a three-dimensional space for the object to be modelled. The user input device is connected to a processor (30) via a link shown figuratively as (25). The processor (30) is connected to a display device (100) via a link shown as (105) the display device having a display screen (101). The processor (30) is further connected to a component memory (10) storing a library (11) containing plural components via a link (15) and to a frame memory (50) storing a library (51) of frames via a link (55). The processor (30) is further connected to a stored program (40) held in a memory via a link (35).

Referring now to Figure 2 which shows a portion of a display of the system in use it will be seen that a frame (200) has been defined. In one embodiment the frame (200) is defined by the use of the user input device (20), for example by means of a graphic user interface and by clicking with a mouse on the corners of the frame. In another embodiment a number of basic frame configurations are held in the

library (51) and one of these is selected for display on the display screen, the user input device (20) being used to manipulate the basic frame to have the required aspect ratios and orientation.

The frame (200) shown in Figure 2 is a wire frame having edges defining six sides (201-206) of which (206) is a bottom, (204) is a top, (203 and 205) are respectively back and front and (201, 202) are respectively sides of an object. In the presently described embodiment the object to be modelled and constructed is a chest of drawers (see Figure 3).

Figure 2 further shows an exemplary extract from the library (11). The extract shows a flat panel (212), a drawer front (213), a triangular element (214) and a flexible element (215).

Referring to Figure 4. A schematic representation of the data for the frame (200) is shown. It will be seen that, in this embodiment, the data constructs (200) includes data for each of the six sides of the frame (200) and the data associated with the side (201) is shown in further detail. This data includes data herein referred to as constraint data (300) which affects whether or not a particular component can be located on the side (201) and also contains other data (320) which, for example, affects how the side (201) relates to other frames or objects. The data (301) of this embodiment comprises three sets of data (301, 302 and 303). The constraint data (300) specifies components that are allowed to be applied to the side (201). In turn each component has compliance data associated with it and there must be full compliance with the constraints (301-303) before a component can be applied to the side (201). In the presently described embodiment constraint data (301) specifies the general nature of the components which is acceptable so that, for example, a drawer front (213) cannot be applied to dress the side (201). The second constraint (302) relates to the orientation of a component so that a component (216) which is intended as a work surface having substantial weight and rigidity suitable only for horizontal orientation can be applied to the side (201). The third constraint (303) relates to the disposition of components. The major function of this dispositional constraint is to prevent a bottom panel from being placed in the position for a top panel, or vice versa.

Returning now to Figure 2, it will now be assumed that the only component that is suitable for the side (201) is the flat panel (212). In practice of course there may be a number of possible components that are suitable for the side (201), and indeed these components may in fact be "completed" frames.

For example the panel (212) in some embodiments is a frame which is dressed by application to it of a component having attributes determined by its material, for example a real wood, a laminate or a fabric finish.

Having selected the component (212), whether it be a component in its own right or a construct of a frame dressed with components at a lower level, the plate (212) is selected and dragged and dropped to be disposed within the side (201).

The stored program which in the present embodiment uses a graphic descriptor language, then modifies the data representing the plate (212) so as to make it fit over the side (201). This is done by stretching or shrinking the dimensions of the plate to make it fit the side. The stretching may be asymmetrical or symmetrical. The adapted component is then displayed in place of the opening (201) of the wire frame (200).

Other suitable components are then applied to dress the frame until the desired chest of drawers has been completed.

The chest of drawers object – see Figure 3 can then be manipulated as an object.

For example it can be placed within a model of a room with other objects. Such a placing may show that the proportions of the chest of drawers (or indeed the room) need to be modified. If modification of the chest of drawers is necessary, this can be performed by using the user input device to stretch or respectively shrink the dimensions. Where desired the change to the shape or other properties of the chest of drawers may leave other features of the chest of drawers (for example the number of drawers) unchanged. However, it is also envisaged that the configuration of the chest of drawers may automatically vary – for example see Figure 3 in which the double drawers at the top of the chest of drawers are replaced by a single double-width drawer.

Preferably any predefined frames from a frame library are provided with intelligent stretch points which enable the dimensions of the frame to be easily altered. These may comprise of points selectable on apexes whereby an apex can be moved towards or away from the frame. The dimensions of the frame are then automatically recalculated and the frame resized to accommodate the newly selected location for that apex. Stretch points selectable by a user may also be provided on surfaces which enable surfaces to be moved. In some cases this may involve simply moving the frame inwardly or outwardly from the object. In other cases, where the frame represents e.g. a roof it may enable the surface to be rotated about one of its sides. Preferably the stretch points provided on frames are selectable by a user input device such as a mouse and associated pointer.

We have already considered constraint data associated with frames and compliance data associated with objects or other frames which interact with a main frame.

In a further embodiment additional constraint data can be applied to objects to enable them to better resemble the real world. Such constraint data can be applied to individual edges or apexes of objects. This enables information about e.g the type of joints between edges to be provided by the modelling system. For example, in the case of a chest of drawers, where the side panels meet the top panel the top edge of the side panel has further constraint data associated with it indicating that it is a wooden edge. The top panel is a wooden panel and when the two are brought together, the user is given a selection of the different types of joint which may be used between the two panels. For example, this could be a glued joint, a tongue and grooved joint, or a bolted joint. Similarly, if two metal panels or edges were brought together the user could be given a selection between e.g. a welded joint, riveted joint, or bolted joint. Preferably, when the system is set up for a particular application the number of joints which can be used is defined and the options offered to the user thereby determined.

Another use of the constraint data applied to edges or apices is that it can be used to enable certain edges of an object to be brought up against another object whilst other edges may not be so positioned. This gives additional versatility over the disposition constraint data discussed earlier.

Whilst a model is being constructed of the object being designed, all the data relating to this object is stored in temporary memory. Once the design has been completed this can be stored permanently. When the system is running on a general purpose computer, the data will normally be stored on the computer's hard disk.

Once an embodiment has been completed, the data associated with the frames and components/objects inserted into the frames can be used to generate full design and construction drawings for the object being modelled. It can also be used to generate inventory lists of all materials needed to construct the object. Graphically, where the system is used with information relating to joints, this will include all materials required to make those joints (e.g. nails, bolts, welding materials etc.).

The system is preferably implemented on a general purpose computer, such as a standard PC. In such cases, the system may be supplied to a user in its basic form with a user able to define his own frames and components in dependence of the type of objects he wishes to model with the system. Alternatively, the system may be provided in a custom version with various predefined frames, components and joints already defined and ready for a user to use. The software is provided on a machine readable data carrier such as a compact disk which a user can load into his computer and can then run the program. In such a situation, the various memory portions illustrated in figure 1 are defined by partitioning the computer's memory when the program runs upon it.

As previously noted, embodiments of the invention have two parts, a general purpose engine part and a custom part for use in a part and/or technical field. The custom part may be implemented at least partly in XML. The custom part may include one or more component and/or frame libraries, and may include data for determining the GUI layout on screen. It may also enable or disable selected parts of the engine part – for example, a roof design application may not require rotation of a roof structure out of the horizontal plane, and hence an embodiment customised for roof design can have the rotation tool provided in the engine disabled by the custom part.

An embodiment of the invention has now been described in the context of furniture design. It should be understood, however, that the invention is not restricted to furniture design and may be used in many fields of technology. More specifically the described features of the embodiment are not to be taken as limiting on the invention which is defined in the appended claims.

Figure 5 is a flow diagram describing the steps followed by a further embodiment of the invention. Figures 6 to 11 are representations of graphical displays presented to the user during the steps in order to identify the options that are available at the different stages. Figures 6 to 11 should be viewed in conjunction with the flow diagram of figure 5. The embodiment of figures 5 to 11 provides a graphical image of an object and allows the user to navigate the image in order to obtain construction data relating to the object. The user can select specific parts or regions of the object, for example particular joints or beams, about which to obtain data.

At 510 the user selects an object to view, in the following example the object is a conservatory to be adjoined to a house although the embodiment could provide information relating to a variety of objects including buildings or similar structures or vehicles. At 520 the selected graphic is presented to the user. The image is shown in figure 6. Preferably the image is represented in three dimensions and the user is able to rotate the object in order to view this from different angles or projections. The image screen provides the user with a number of facilities for obtaining information about the object including a magnifier facility. Further embodiments also include features such as a tape measure which provides the full dimensions of the object as shown in figure 7. At 520 the user is able to select which tool he wishes to use to obtain data relating to the object.

Figure 8 is a representation of the display screen when the magnifier tool is selected at 530. The magnifier produces a part selector frame which shows magnified detail of the area of the object over which it is positioned. The centre point of the frame is the focus. Once the user has magnified the area of interest at 540 he may select the area to obtain a more detailed layer of data.

Once the area of interest has been selected, the image identifies a number of points within the area about which further, detailed, information may be obtained

at 550 as shown in Figure 9. These points are identified as "hot spots" 910, 920 and 930 on the graphic and can be selected by the user by moving an icon over the relevant hot spot (using a computer mouse etc or by selecting using the keypad). Generally, hot spots will be positioned on joints and beams or regions of particular complexity. When a hot spot is selected by the user at 560 embodiments of the invention will retrieve from memory and present the user with a choice of information that is available about the selected hot spot at 570 including building instructions (either text or video), the materials required for that section, data related to relevant computations, (for example the forces withstood by that beam or joint), different images of the area and a description of the area. These options are identified on the display. At 580 the user selects which information he requires and this is retrieved and presented on the display at 590. Figure 10 is an example of a display when a user has selected to view the materials required by a particular hot spot.

There may be particular areas of the object which have a number of increasing layers of complexity, for example when navigating an image of a vehicle the graphic may show the chassis, beneath which is the interior and engine etc. In such areas of complexity the device would indicate to the user that the magnifier feature remains available in order to tunnel down into deeper layers of the design. Otherwise, the display will identify that further hot spots are available within the area and that these can be selected and data relating to the hot spot can be displayed. Preferred embodiments indicate the level of complexity of the object that is presently being viewed 940. Such embodiments enable the user to return to the highest or lowest level quickly and easily without having to navigate out the system.

Further embodiments of the invention enable the user to select for all hot spots to be displayed on an image without requiring the magnifier frame over the area containing the hotspot. Such a display is shown in Figure 11.

In general, all data will be programmed into the graphic package and will not be editable by a user. However, more advanced embodiments of the invention will enable the user to change the dimensions of the object, as discussed above with reference to figures 1 to 4, and will automatically update the data relating to the different joints etc as the design is updated.

Embodiments of the invention operate by linking data about particular points of the object to a graphical representation of that point on the graphic display, ie the hot spot. The data associated with different hot spots, for example the physical components of the structure, the forces experienced by the beam or the instructions for constructing that joint, are stored in memory and linked to that hot spot. When a user selects a hot spot the system recognises that there is information stored in associated memory which carries relevant information. At that stage the system identifies to the user that further data is available and the type of data that is available. When the user selects the required data, the data is retrieved from the memory and presented to the user on the display.

Further embodiments of the invention provide a facility by which an object can be edited by a graphical tool and the data relating to that object (for example the dimensions and components) are automatically updated accordingly. Figure 12 shows an example of an object in a frame, the object being a chest of drawers. The frame may include several objects or a single object. The frame of Figure 12 includes various constraint data applied to, for example, the height, proportions or orientation of the device. However, the user is also presented with the option to change particular features of the object, for example, the dimensions, the type of joints or the number of drawers. Such options are presented to the user to aid the design of the object. In each case the system recognises the options that are available for each feature. For example, if the user has selected a wooden chest of drawers, the joining method options may include glued, tongue and grooved or bolted. In contrast, if the object was designed from steel then the user may chose welded, riveted or bolted joints. The options for each feature will be interlinked such that options are only provided which tie up with the other features of the object. In the example of Figure 12, the user is presented with the opportunity of changing the moulding, dimensions, component materials, joining methods, the raw materials, the type of handle and the number of drawers. Each feature can be changed by selecting the required feature and then selecting the available option for that feature. The frame will include the constraint data and will only permit modification of the object within the constraints.

Once the object as shown in figure 12 has been designed, embodiments of the invention provide the user with the facility to obtain detailed documentation about

the designed object. Once the object is designed the user will be presented with the option to view the object in isolation in order to obtain detailed information about that object. Examples of information that may be available are manufacturing drawings, cost calculations, ordering lists of required components, installation drawings, installation descriptions, certificates, delivery information, cutting plans or manufacturing data. The data may be in the form of drawings, video data, audio data or text.

The embodiment of figures 12 and 13 provides a powerful design tool which is simple to use. The user is presented with a series of options and constraints within which he can design his own object. The available objects and constraints are programmed into the system in order that the user is not able to design an object which includes incompatible components eg welded joints in a wooden object or which does not fit into a particular position in a room defined by a frame. The user is able to manipulate and configure the object using a front end graphic interface while, as the alterations are made to the graphic, consequent amendments are made to the data in the memory which define the object. The data in the memory related to each feature are interlinked in order that any constraints imposed by a particular choice of feature influence available choices for other features.

Preferred embodiments of the invention incorporate hot spots (as discussed above in relation to figures 5 to 11) to access the data from the object. Initially, the object will be presented within the frame. The object can be selected using a magnifier window feature as discussed above. When the magnifier glass feature is moved over the object the object is enlarged and the data available on the object is indicated by means of icons or hotspots identifying the data. Figure 14 shows an object when positioned under the magnifier glass tool in which icons appear on the object to identify where data is available. On selection of the object, the object is presented in isolation as shown in figure 15. Links to the data available about the object may be indicated as icons on the object or by a link on the side of the display. Preferred embodiments include links to details about different aspects of the object. Effectively, this allows all hot spots to be presented in a single display, for example drawers and handles. In the embodiment of figure 15, data about the handles may be accessed directly rather

than being a subset of the drawers and requiring a selection of the drawer and, within that selection, the option of handles. Further command links enable the user to return to the editing screen. If a user selects one of the different levels of the object he can obtain data relating to that level.

Once the user has selected the level of the object to view, that level, or feature, is presented in isolation and further hotspots are identified where available. Figure 16 shows the display when a user has selected a feature or component of the object, for example a drawer. When selecting this component part the user is presented with further hotspots identifying data specific to that component in isolation, for example the cost of different parts or the specification of the different parts. Once the user has selected the component parts of the object he can return to the graphic of the complete object as shown in Figure 17.

If the user selects the global link the whole object is shown. Typically, data hotspots shown on that level relate to the entire object. If a different level is selected the data hotspots will change and only be related to that level.

Further embodiments may indicate, in a separate graphic, the portion of the object which is currently being viewed in the magnifying glass tool by showing the whole object or frame and by highlighting the currently viewed section.

It will be clear to those skilled in the art that embodiments of the present invention provide a graphical representation of an object which is linked to further data relating to specific parts of the object including, images, text, video, vector graphics or 3D geometry. By passing a mouse over the hot spots or by selecting by other means the user may zoom in or out of the image to view more or less detail. Each level of the hierarchy is parametric and is therefore customised to the content. Thus a user is provided with an initial, simple, view of the object and he is able to select to tunnel down into deeper layers of the object and obtain more detailed information about particular areas or parts of the object. Such embodiments provide an easy to navigate system capable of providing detailed information relating to the construction of an object.

It will also be clear that embodiments which allow editing of objects and update the data relating to those objects accordingly provide powerful design tools which

enable a user to modify a design within specific constraints, and then be provided with detailed construction data relating to the new design. It is expected that such embodiments will have implications in the general field of design as well as enabling users to design unique objects from catalogues.